

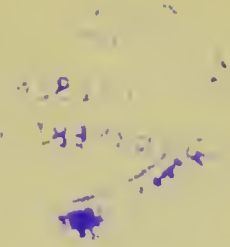
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The Healing of Rodent Cancer

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By J. INGLIS PARSONS, M.D.

131 F



THE HEALING

OF

RODENT CANCER

BY ELECTRICITY

BY

J. INGLIS-PARSONS

M.D., M.R.C.S., M.R.C.P.(LOND.)

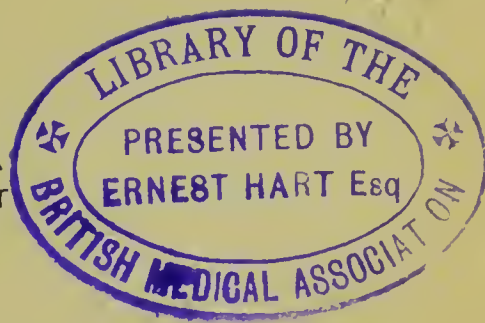
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London ; Fellow British Gynæcological Society, &c., &c.*

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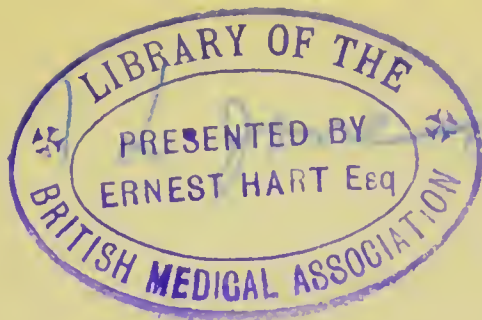
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PREFACE.

AT the request of many medical and other friends who have seen the results of my treatment by electricity, I decided to publish this monograph.

Those who have studied this branch of science well know how difficult and abstruse it is, and how large a field there is open to the pioneer. For other forms of malignant disease I am still continuing my investigations, and at some future time shall publish the results.

3, QUEEN STREET, MAYFAIR,
LONDON, W.

October 10, 1893.

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ERRATA.

Page 57, line two from bottom, for
“ nine needles ” *read* “ two needles.”

THE
Healing of Rodent Cancer by
Electricity.

BY

J. INGLIS PARSONS, M.D., M.R.C.P., &c., &c.

RODENT cancer, or, as it is often called, rodent ulcer, is a most serious and distressing disease. When left unchecked it causes frightful disfigurement. No tissue can resist it ; although its progress is slow it never stops unless arrested by treatment. Gradually and persistently it continues to destroy. In some of the worst cases the greater part of the face, including the nose, cheeks, even portions of the brain and both eyes, have been eaten away, and the condition of the sufferer has become deplorable in the extreme.

Half a century ago this disease was con-

founded with lupus, syphilis and the infective forms of cancer. The investigations of Warren and Moore have placed it on a sound basis.

NOMENCLATURE.

All authors are now agreed that what used to be called rodent ulcer is a local form of malignant disease, presenting a strong resemblance to the true epithelioma.¹ Sir James Paget included it among the cancerous ulcers : "The pathology of rodent ulcer has, during the past few years, been studied with so much success that it is possible now to class them among the cancerous ulcers. This being so, it seems scarcely necessary still to call them rodent ulcers. Probably the term will gradually cease to be employed." Moore² called it rodent cancer in his book. Lébert³ and Thiersch⁴ include it among the epitheliomas. Billroth⁵ considers it to be a mild form

¹ Holmes' "System of Surgery," vol. i., p. 153.

² Moore's "Rodent Cancer."

³ Lébert, "Traité des Maladies cancéreuses."

⁴ Thiersch, "Epithelial Krebs," 1865.

⁵ Billroth, "Surgical Pathology."

of cancer of the skin. In addition to these, other names have been employed, such as "cancroid," "noli me tangere," "ulcère chancreux." Mr. Cæsar Hawkins included it among the cancerous diseases.

The term "rodent ulcer" does not convey sufficient idea of the severity of the disease. I propose, therefore, to follow Moore's example, and call it rodent cancer. The latter term expresses the malignant character of the disease, while the former serves to distinguish it from other forms of carcinoma.

PATHOLOGY.

The late Mr. C. H. Moore seems to have been the first in England to observe the true character of the disease revealed by the microscope. In his book on "Rodent Cancer," published 1867, he stated: "I have found parts of the diseased substance, presenting a minute, textural composition, precisely answering to that of the epithelial form of cancer. A portion of the solid substance taken from the interior of the frontal bone

showed just such appearances as the ordinary cancer of the lip—epithelial cells, brood cells like the section of an onion, many fragments of cells and nuclei, very distinct, round, dark granular cells and oil.”

Mr. J. C. Warren in his able essay on the “Anatomy and Development of Rodent Ulcer” gave his opinion as follows:—“We have, then, to recapitulate two forms of cancer of the skin. First, the large cell variety, or the infiltrating form, for which we may select cancer of the lower lip as a type. We find a greater degree of malignancy in this form, both in the more rapid growth and in the liability to an infection of the neighbouring lymphatic glands or of distant parts. Second, the small cell variety, or flat, or superficial cancer, the most typical form of which is the rodent ulcer. This form is characterised by a slow growth, and is very rarely followed by an infection of distant parts.”

My own observations agree entirely with these authors, except that the term “infiltrating,” restricted by Dr. Warren to the



PLATE I.

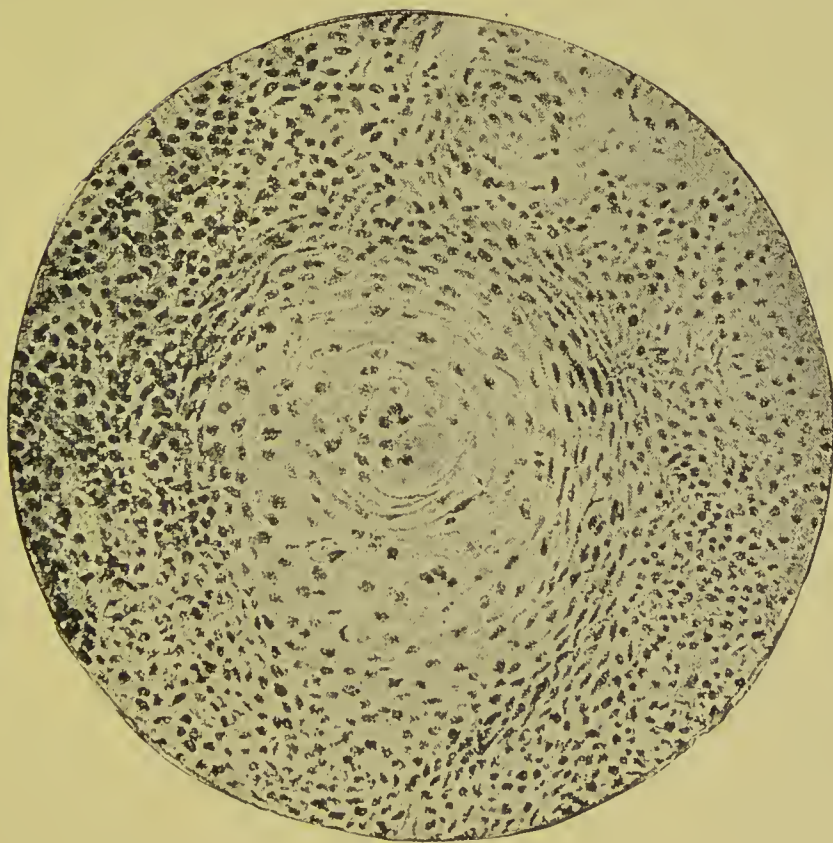


PLATE II.



infective forms of epithelioma, is to my mind equally applicable to rodent cancer. The main distinction between rodent cancer and true epithelioma is that the former infiltrates and destroys, but does not infect glands or distant parts, while the latter offends in both respects. That is to say, true epithelial cancer both infects and infiltrates rapidly, while rodent cancer infiltrates only, and that slowly.

Sections taken from a small piece of growth removed from Case IV. exhibited the following characteristics:—Pervading all parts of the diseased tissue are large numbers of new cells. The majority have the appearance of small epithelial cells. In the older portions of the growth they exhibit the irregular and larger shape characteristic of the squamous cell epithelioma, are more crowded together, and in places form the concentric arrangement called epithelial nests. These birds' nest cells are fairly numerous and vary in size, some of them are quite as large as those found in the infective form of epithelioma (*vide* plate II.). The arrangement of the

small epithelial cells varies in different parts—in one place aggregated into columns as if pushing their way into the healthy tissue; in another part filling an alveolus formed by delicate fibrous tissue; while a great portion of the stroma appears to be a structureless matrix, and with the new cells imbedded in it, and has very much the appearance of a round cell sarcoma. In fact, before coming to me, this growth was first removed by the knife, and examined by a competent pathologist, who pronounced it to be a sarcoma! The small cells already described are found most abundant in the newer portions of the growth, and in the immediate vicinity of blood vessels. In the tissues surrounding the ulcer, and chiefly in the papillæ of the skin, they are very numerous.

Dr. Warren, speaking of his sections, stated “at no point was any communication to be found between the cancer cells and the normal epithelium of the part, although a careful examination was made with this object in view. It seems justifiable, therefore, to con-

clude from the data afforded by these observations, that in some instances, at least, the cancer cells are in no way connected during their development with the previously existing epithelial structures, and that we are to seek for their origin among the young cells of new formation which are present in large numbers, and with which the cancer cells appear to come into intimate relation. Indeed, we are able to observe in both these cases such a gradual change in the character of the cells, from the earliest pathological change, to the fully developed diseased structure, as to leave hardly any room for doubt upon this point."

This opinion is untenable at the present day. The disease begins in the skin, where epithelial cells are plentiful, and the large number found is the result of their active proliferation. There can be little doubt now that every epithelial cell is derived from a similar cell. The large number of new cells found is no argument against this view, if we remember that all the cells of the body, even in a man of 50, contain a vital capacity of re-

production, to last something like another twenty-five years, sufficient to make good and repair the shedding of the cutis during the whole of that time. If this latent capacity for necessary proliferation over a long period is suddenly concentrated on a comparatively short space of time, there seems to me to be no difficulty in allowing that all the epithelial cells found may be derived from cells of the same type.

Having studied the morbid anatomy and mode of growth, we are still in the dark as to the cause of the disease. Why should one person have rodent cancer and not another? In malignant disease, whatever the cause may be, there must, I think, be two factors. One is a constitutional defect and the other is a local cause. It is a matter of common observation that true malignant disease nearly always commences either in some ulcer or abrasion of surface at some point in the body more than usually subject to irritation. But then, while one man who gets a sore on his tongue from smoking will eventually suffer from epithelioma, another with a

similar sore does not develop any disease. Both have the local condition necessary for its development, but only one has the constitutional defect which enables the disease to establish itself. I suggested a hypothesis in my first paper on malignant disease, which seemed to harmonise with many of the facts observed. Shortly, it amounts to this. Since malignant disease nearly always commences either in a sore subject to chronic inflammation, or in some tissue liable to frequent irritation, such as the uterus or breast, is it not likely that the frequent efforts at repair lead eventually to such an active proliferation of new cells, that some of them escape from the control of the nervous system and take on an independent existence? There can be no doubt of the association of nervous debility with commencing malignant disease. If this hypothesis be allowed to be true, the two factors are as follows :—Firstly, a constitutional defect, or want of control by the nervous system over the active proliferation of cells that takes place during the reparative process ; secondly, a local sore or tissue subject to chronic inflammation and irritation.

No nerve endings have ever been found in malignant tumours, consequently it is impossible for the vaso-motor nerves to act on the blood vessels and increase the circulation through them so as to repair the effects produced by an injury. Even if the nerves were present the blood vessels are devoid of muscular fibres, and cannot dilate so as to enable extra supplies of nourishment to be brought for the recuperation of the malignant cells over and beyond their normal requirements. In this respect they are at a disadvantage in comparison with the healthy cells, with their carefully regulated vaso-trophic and motor nerves and elastic blood supply, capable of increase or decrease according to their requirements. In other words, we may say that the vitality of the malignant cell, or its recuperative power from injury, is lower than that of the healthy cells. How great or how little this difference is it is impossible to say. From practical experience I am convinced that there is a difference. My aim has been to adjust the strength of the electric current, so as to kill the malignant cells,

yet not to injure the healthy cells beyond recovery.

Rodent cancer is so nearly allied to true malignant disease, that it will probably be found to be due to the same causes. Possibly the constitutional defect of those subject to rodent cancer occupies an intermediate position between those who are liable to true malignant disease and those who never take it. The disease is able to get a footing, but finds a difficulty in overcoming the vital resistance of the healthy tissues, and therefore remains local and grows slowly.

There is another hypothesis for malignant disease, which is now gathering considerable force, namely, that it is due to the presence of parasites.

If this turn out to be correct, we shall have a satisfactory and scientific basis for treatment. Cohnheim believes that tumours in general, and malignant tumours in particular, are due to the exaggerated proliferation of primary foci detached from the embryonic folds, and gone astray in different parts of the organism. He considers that

these embryonic centres remain quiescent for any time between 20 and 50 years, without giving any sign of their presence, then suddenly, from some unexplained cause, wake up and commence to grow. Metschnikoff will not agree to this, and points out that embryonic folds occur in the invertebrate animals as well as the vertebrate, but yet the invertebrates never suffer from tumours resembling carcinoma. If, then, the malignant tumours are due to these embryonic centres, why should the invertebrates be exempt? On the other hand, we find tumours to be very common among the invertebrates and inferior organisms in general, but then these tumours are always of parasitic origin. In the lowest scale of living things all neoplasms are of parasitic origin. Against the parasitic theory it may be said that carcinoma and other tumours are neither epidemic nor endemic, nor can carcinoma be transmitted from one individual to another. This is no proof against a parasitic origin. Tuberculosis is neither epidemic nor endemic, yet every one agrees that the disease is due to a bacil-

lus. Malaria is not contagious, but it is infectious, because caused by microbes.

There is no doubt that true tumours are caused in the rabbit by parasites known by the name of coccidia. It is an infectious parasitic disease, but it is never contagious. In young rabbits the disease is fatal, while full-grown rabbits seem able to withstand its ill effects. The tumours caused by this parasite occur chiefly in the liver. They are seen under the microscope to consist of numerous ramifications of the biliary ducts, surrounded by connective tissue. The epithelium retains its ordinary properties, and is analogous to the malignant adenoma of the human species. It is caused by a parasite, and belongs to the miasmatic diseases. The coccidia found in the liver of rabbits are oval bodies closely resembling the ova of entozoaria. Before they can give the disease to fresh rabbits they first undergo a transformation outside the organism. At a temperature of 15° to 25° C., lying in earth or water, the coccidium divides into four spores. Each spore has a strong ex-

ternal covering, and encloses two falciform and very delicate embryos. These spores, when swallowed, liberate embryos and give birth to new parasites, and thus cause the malignant disease. They penetrate into the epithelium of the intestines and of the biliary ducts, where they grow and become transformed into the oval parasites of the adult form. Coccidiosis, therefore, is a parasitic disease of miasmatic origin, which gives rise to true malignant tumours in rabbits.

M. Laveran has shown that man suffers from one coccidian disease when he discovered the parasite of malaria. It differs, however, from the coccidium of the rabbit by infecting the red corpuscles of the blood instead of the epithelium. This shows that at any rate man is subject to one coccidian disease.

It is not likely that some other form of coccidiosis is the cause of cancer ; for although it cannot be said to be endemic to the same extent as malaria, it does to a great extent approximate to the miasmatic diseases. It is far commoner in some regions than in

others. Further, it resembles the coccidiosis of rabbits, in the active proliferation of epithelial elements.

Within the last few years, numerous observers have declared the presence of parasites in the malignant tumours of the human subject. We are indebted chiefly to Messrs. Darier, Albarran, Wickham and Vincent, in France, Thoma Sjöbring, Henxelom in Germany, for the pioneer work in this direction. In spite of much opposition on the part of several observers, these scientists have held their ground and been supported by others. Sondakewitch in Italy, Ruffer and Walker in England, Sawtchenko of Kieff, all agree with them not only about the presence of a parasite, but also about its general characters and appearances.

If it should ever be proved that cancers are caused by these minute parasites, the benefits derived from the use of electricity could be equally well explained. It is well known that electric discharges of sufficient power are fatal to minute organisms. The whole question, then, of the utility of elec-

tricity from a scientific point of view would appear to turn upon the relative electrical, as well as vital, resistance of the parasite as compared with its surrounding media.

At present the life history and all the stages of the parasite in man have not yet been made out. Some very good observers deny that the appearances described are parasites at all. For the present, therefore, the pathology of cancer is an open question.

CLINICAL APPEARANCES.

At the commencement, the patient notices a small pimple on the side of the nose or between the eye and the nose, occasionally on the upper lip. It is not painful or tender like the inflammatory papules which are of not unfrequent occurrence in persons of gouty habit and sluggish livers. Instead of forming a pustule or disappearing by absorption, the pimple begins to ulcerate, and a small scab forms. It continues to increase in every direction, gradually extending into the healthy tissues around ; meanwhile ulceration

proceeds in the older portions of the growth. The original pimple before long disappears, and its place is taken by an ulcer.

The *appearance* and characters of the disease vary, according to the period at which it is seen. In the early stage, at the end of a year or two, the ulcer presents a sinuous and slightly elevated border. The base is smooth, glazed, of a dull red colour, and devoid of granulations. Sometimes the base is covered by a yellow-brown or black scab, derived from the scanty discharge mixed with blood dried by the atmosphere. There are no tubercles in the surrounding area, and very little induration.

In the later stages of the disease, when the growth is more rapid, or if it has been allowed to go on unchecked by treatment, the appearance is entirely different. Instead of the edge of the ulcer being slightly raised, it may be as much as a quarter to half an inch thick. Both appearances are not unfrequently seen in the same case, the edge being thick in one part while it is thin in another. The late Mr. Moore fully described this difference, but

other writers seem to have overlooked it. It appears to depend partly upon the relation of the ulcerative process to the rapidity of growth. When ulceration is rapid and the growth slow, the former overtakes the latter and comes close up to the healthy tissues, and the ulcer has only a thin border. Under these circumstances some cicatrization may take place, but it is only partial, and never complete. On the other hand, when growth is more rapid than ulceration, a thickened border is formed. It is rarely hard, and may be soft, rather elastic, and with a semi-translucent appearance which is very characteristic. As a rule there is no enlargement of the lymphatic glands corresponding to the seat of disease, even with advanced cases. This point alone, and the slow progress of the disease will, in most cases, enable us to differentiate it from a true epithelioma. Occasionally a gland is found to be enlarged and hard, from inflammation, and may even go on to suppuration, while in other cases the enlargement will subside of itself. I believe, in these cases, that some septic absorption

takes place from the surface of the ulcer, and that the swelling in the gland is purely inflammatory.

The disease for some years is quite painless, and hardly seems to interfere with the general health. In the latter stages, when ulceration has commenced to eat through some of the nerve trunks, intolerable agony may be caused. This, combined with the constant discharge and hæmorrhage from a large ulcerated surface, soon tells upon the general health and causes depreciation of the vital powers.

The progress of the disease is very unequal. It is on this account that the edge of the ulcer presents a notched and serrated appearance, giving rise to the title, Rodent. While spreading superficially over the surface, it also advances in depth. The extent to which diseased cells extend into the healthy tissues, without giving signs of their presence, varies. In recent parts it is not more than a line or two, but in the older parts it goes deeper. It also varies very much in different cases, in some burrow-

ing deeply, while in others it keeps more superficial. Every kind of tissue is destroyed. In the worst cases that have been allowed to go on without treatment it is not unusual to find the whole of the nose, part of the face, one or both eyes, the roof of the orbit, and even portions of the brain destroyed. Cartilage, bone, mucous membrane, connective tissues—all disappear before its inroads.

No more ghastly sight can be seen than an advanced case of this disease, with all the features of the face obliterated, and their place taken by an enormous ulcerating cavity.

Like other forms of cancer, the disease mostly commences late in life, rarely before forty-five. Moore had one case as early as thirty-three. The majority occur after fifty, very often in persons of good general health and vigour. There appears to be no association with other hereditary disease. Two of my cases, however, had near relations who had died from true carcinoma. Syphilis only occasionally precedes it. With regard to sex, it appears to be rather more frequent in men.

Rodent cancer is always slow in growth, but it steadily progresses and never stops spontaneously. In the worst cases it may threaten life in five to eight years from the commencement of the disease, while in others this will not occur for twenty years. Much depends upon the situation. On the forehead, temple, and neck, it is nearer to vital parts, and therefore more dangerous than when it occurs on the face.

When the disease is allowed to go on unchecked death occurs either from gradual exhaustion produced by the copious discharge of a large ulcer, or from hæmorrhage.

DIAGNOSIS.

In most cases there is not much difficulty. The age of the patient, the slow progress of the disease, the absence of pain, of lymphatic enlargement, the situation of the disease, and the appearance of the ulcer serve to distinguish it from lupus epithelioma and syphilis.

Lupus is found in families with a tubercular history. It occurs in young subjects.

Spontaneous healing takes place in one spot while ulceration is proceeding in another. The ulceration is superficial, often multiple. Round the margin may be seen several soft tubercles. True epithelioma begins generally at the junction of mucous membrane with skin, but not always. It grows more quickly than rodent cancer, and soon infects the lymphatic glands. The margin and base of the ulcer are more indurated. The surface is rather dry and scaly. There is more infiltration into the surrounding skin. Removal of a small piece, and examination under the microscope would reveal the characteristic structure.

Syphilitic ulceration of the face is more rapid than rodent cancer. There is no indurated border to the ulcer. The edge is thin and undermined, and surrounded by a bluish margin of skin which is very characteristic. The surface of the ulcer is rough and irregular, with spots of suppuration. If a history of syphilitic infection cannot be obtained, traces of the disease can generally be found on other parts of the body. The disease will

also improve under the administration of mercury or iodide of potassium.

ELECTRO-PHYSICS.

In these days of scientific research, when the physician and surgeon, in addition to the necessary knowledge of the structure and functions of the human body and its enormous variety of diseases, must also combine a considerable acquaintance with the collateral sciences of chemistry, botany and biology, it is no wonder if the study of electrophysics is neglected. In these pages I have endeavoured to give an outline of elementary principles for the benefit of those who have not studied electricity.

To apply electricity with success the operator must be master of his armamentarium. He should be able to test his battery before going into action, and to repair it if necessary. It is no use to rely upon the services of some workman or tradesman from whom batteries are obtained. He is very likely to be more ignorant than the

operator. It is not possible in a small book to give more than a brief explanation of the general principles. I shall avoid technical terms as much as possible.

Electrical energy can be produced in a variety of ways. We have only to deal with that produced by chemical action, and known by the name of Galvanic or Voltaic electricity. A number of cells, each containing a supply of dilute sulphuric acid, with a plate of carbon and zinc, are joined together to form a battery. Take one of these cells and join the zinc to the carbon by a wire outside the cell. We shall then find that the acid acting on the zinc plate causes a flow of electricity within the cell from the zinc to the carbon, and outside from the carbon to the zinc. Thus a circuit is formed. Outside the battery the zinc is called the negative element, and the carbon the positive, and the direction of the current is from the positive to the negative. The battery is composed of a large number of these cells joined together in what is called in series — the positive pole of the first cell to the negative

pole of the second, the positive pole of the second to the negative pole of the third, and so on until all the cells are connected.

When we wish to pass a current from a battery through the human body, it is necessary to know what strength of electricity we are using. For that purpose an instrument is employed called a galvanometer. Most of these indicate the strength of the current by the deflection of a magnetic needle. The greater the deflection the stronger the current. Without an instrument of this kind we should never know what strength of current we were using, because it depends upon two factors—the pressure of electricity in the battery and the resistance to its passage in the circuit.¹ Electricity is very like water in this respect. The flow of water from a tap depends upon the pressure of the water in the cistern, and the length and size of the pipe. A long small pipe offers great resistance, and only allows a little water to pass, although the

¹ The size of the battery and the number of cells cannot alone indicate the strength of the current.

pressure from the cistern may be high ; on the other hand a large short pipe with very little resistance allows a large quantity of water to run through, even if there is not much pressure. So it is with electricity : we may increase the number of cells in the battery and so increase the pressure, but the strength of the current will also depend on the resistance in the circuit. Ohm investigated the relation between pressure and resistance, and he embodied it in the following law :—“ The strength of the current varies directly as the electro motive force, and inversely as the resistance of the circuit.” Put into a formula it stands as follows :—

$$\text{The current} = \frac{\text{electro motive force}}{\text{resistance}}.$$

Electro motive force is the scientific term used to denote the pressure of electricity. When we want to describe how much pressure we use the word “ volt,” and say that the electro motive force is so many volts. Substances offer different resistances to the passage of a current, and they vary through very wide limits, from copper, which is a very

good conductor, to vulcanite, which offers enormous resistance and is called a non-conductor. Whenever electricity is used we must therefore take into account the resistance in the circuit. In order to do this we require some term having a definite meaning by which we can express the amount of resistance. The unit selected for this purpose is called the Ohm. We also need a unit to describe the strength of any current, since it depends upon both the electro motive force and the resistance. The ampère is the standard for this purpose. As one ampère means a large volume of electricity, too great to apply to the human body, we divide it into a thousand parts called milliampères.

To recapitulate, there are three units in electricity, the Volt or unit of electro motive force being rather less than that obtained from one Daniell's cell. For convenience, Electro Motive Force is written E.M.F. The Ohm being the resistance offered by a column of mercury one square millimetre in section, and 106 centimetres in length. The Ampère or unit of current strength obtained

by passing an E.M.F. of one volt through a resistance of one ohm. Some voltaic cells have a higher E.M.F. than others. The most powerful are the Grove and Bunsen. Unfortunately they give off fumes when in action, and are therefore unsuitable for medical purposes. In addition to the E.M.F. of each cell, we must also consider the internal resistance to the passage of the current within the cell itself. The higher this is the smaller the amount of electricity given out. For instance, the Daniell cell has an E.M.F. of about one volt, while a Grove cell has about two volts. The internal resistance of the Daniell is about five times that of a Grove cell of equal size; consequently, although the Grove has only double the E.M.F. of the Daniell cell, it will give eight times as much current through a short stout wire. In addition to the internal resistance being dependent on the materials used in the cells, it also depends upon the size of the cells. It is a very curious fact that the E.M.F. of a cell the size of a thimble is equal to the E.M.F. of a similar cell however

big it may be, even if it were twenty feet square. But then the internal resistance of a large cell is smaller than that of a small cell, because the larger surface gives a greater number of paths for the current to traverse. It follows from this that when a battery is required for the purpose of sending a current through the human body or through anything having a high resistance, it is necessary to have a large number of cells, so as to increase the E.M.F. or pressure. They need not, under these circumstances, be of large size, because the internal resistance will then form but a small proportion of the whole resistance that must be overcome. For example, according to Ohm's law :—

$$\text{The current} = \frac{\text{electro motive force}}{\text{resistance}}$$

$$\text{or } C = \frac{E}{R}.$$

Take the resistance of the body at 4,800 ohms. Suppose we wish to apply 9 or 10 milliampères to test some muscles.

$$\text{Then } C \times R = E$$

$$\begin{aligned} .009 \text{ ampère} \times 4,800 \text{ ohms,} \\ = 43.2 \text{ volts.} \end{aligned}$$

If we use Leclanché cells with an E.M.F. of 1.5 volts, we should require about 29 cells. The internal resistance of the small portable size is about .8 ohm, or for 29 cells about 23.2 ohms. If this be added to the 4,800 ohms resistance of the body, it will make very little difference to the strength of the current.

Thus—

$$\frac{43.2 \text{ volts}}{23.2 \text{ ohms} + 4,800 \text{ ohms}} = .0089 \text{ ma.}$$

or 8.9 milliampères instead of 9. If a battery is required to heat a cautery made of platinum wire, the current, instead of having to pass through a resistance of 4,800 ohms, will only have to overcome about 1.6 ohm. Under these circumstances, in order to obtain a large quantity of electricity, it is better to use a few large cells with a low internal resistance. Let r represent the internal resistance and R the external. If we use three large cells with an E.M.F. of 1.5 volts, but an internal resistance of .04 instead of .8 ohm, the equation stands as follows:—

$$\frac{4.5 \text{ volts}}{r .12 + R 1.6 \text{ ohms}} = 2.6 \text{ ampères,}$$

or 2,600 milliamperes, more than sufficient to render a short platinum wire red hot. If we used ten small cells with the same E.M.F. but an internal resistance of .8 ohm, the current obtained would only be 1.5 amperes, or 1,500 milliamperes, less than we should obtain with three large cells. Evidently no one battery will serve all purposes. For a low external resistance we must employ large cells with a low internal resistance, and for a high external resistance we must have a large number of cells with a high electromotive force.

POLARISATION.

The elements of the Stohrer batteries are zinc and carbon dipped in a weak solution of sulphuric acid. When the circuit is completed a chemical reaction takes place, the zinc combines with the sulphuric acid to form sulphate of zinc, and hydrogen is liberated. The bubbles of hydrogen are evolved at the carbon plate, and sticking to its surface form a film of this gas. The effect of this

is to reduce the strength of the current coming from the battery. It does so in two ways. Firstly, by increasing the internal resistance, hydrogen being a bad conductor. Secondly, by setting up an opposing electromotive force. The nascent bubbles of hydrogen gas are electro positive and easily oxidised, and a current is set up in an opposite direction to that of the carbon and zinc. In order to prevent polarisation, the negative element within the cell should be made with a rough surface; the bubbles then rise quickly to the surface and are got rid of. Another way is to introduce some oxidising substance to combine with the bubbles of hydrogen as fast as they form, as in Poggen-dorf's bichromate battery.

When the circuit is not made, the current cannot flow, and there should be no chemical action going on in the battery. If the zincs were always pure such would be the case, but commercial zinc contains a large number of impurities, consisting of particles of iron, arsenic, and other metals. Each of these particles acts to the zinc like the

carbon plate in respect to its difference of potential. As these impurities are in contact with the zinc and acted upon by the acid, hydrogen gas is given off, and a number of little local currents are set up, which lead to rapid wasting of the zinc plate. To prevent this the zincs should be amalgamated with mercury. The surface is first cleaned by dipping it into acid, and then a few drops of mercury are rubbed over the surface with a piece of linen rag tied to a stick. The mercury unites with the zinc, forming an amalgam. The particles of iron do not dissolve, but float up to the surface, and are carried off by the bubbles of hydrogen. As the zinc dissolves, the film of mercury unites with fresh portions, and thus continues to present a clean, bright surface to the acid. The same result can be achieved by adding some bisulphate of mercury to the sulphuric acid in each cell.

BATTERIES.

There are many kinds of batteries, and each form has its disadvantages. In some the

E.M.F. is not high enough, in others the internal resistance is too high, while others polarise very quickly. To my mind the first consideration is to use a battery of simple construction, so that if it gets out of order and will not work, the operator can soon find out the fault and quickly repair it. In this respect the Stohrer batteries stand foremost. They also have a high E.M.F. of 1.8 volts to each cell and are fairly constant, and the internal resistance is not too high. On the other hand, the batteries are rather heavy and the cells are quite open, so that the contents are easily spilt and the carbons sometimes break. With ordinary care they travel very well. I took two of them from London to Guernsey and back, and only one carbon broke on the journey. Before being moved the cells are emptied of acid, and then refilled, when they have arrived at their destination, with commercial sulphuric acid diluted, one part of acid to ten of water. If we compare one of these batteries of forty cells with a portable Leclanché of the same number of cells, we find that the Stohrer gives out just double

the amount of electricity, measured by a Gaiffe's coulombmeter. The operator should always take this instrument about with him. It consists of two glass tubes, one within the other; the inner tube is graduated in coulombs and contains two platinum wires that communicate with the poles of the battery to be tested. Two movable cork stoppers fit the mouths of the tube; the inner tube and half the outer are filled with water. When the current is turned on, the water in the inner tube is decomposed. The gas collects in the top of the tube and forces the water down. The volume of gas formed in a given time can be read off and expresses the energy of the current. A freshly charged Stohrer hospital battery of forty cells when connected up with the coulombmeter ought to produce a volume of gas sufficient to fill eight of the coulomb divisions of the inner tube in one minute. By this means any battery can be tested and compared with another, and its output of electrical energy ascertained without making any calculations of the E.M.F. and internal resistance of the cells.

GALVANOMETERS.

I have already explained that the strength of a current when passed through the body from a galvanic battery will depend upon the E.M.F. of all the cells divided by the sum of the internal and external resistances. By ascertaining the E.M.F. and R. we can always calculate the strength of our current according to Ohm's law. A much simpler method is to use a galvanometer. It has been found that when a current flows round a magnetic needle, a deflection of the latter takes place, while the current passes. By suitable arrangements it has been found possible to measure quite minute currents with a very sensitive needle; others are constructed for the measurement of large currents. For a constant current not exceeding 250 milliamperes, that made by Gaiffe, of Paris, is about the best. When using more powerful currents for malignant disease, I find that Edelmann's answers best. It is so arranged that it will register up to 100 or to 1,000 milliamperes. It is especially useful for

measuring slow alternations, say of one per second. It is not always possible to accurately measure a current of this kind by Edelmann's galvanometer, but an approximate opinion can be formed which is enough for practical purposes. The inertia of the needle prevents it from swinging right round when a current of 400 millampères is suddenly turned on. In fact, the position which the needle takes up is very much the same as it would be if the current were gradually raised from zero to 400 millampères.

Undoubtedly the best galvanometer for the alternating current is that invented by Major Cardew. Here the deflection is caused by the development of heat in a special wire of higher resistance than copper. At present this galvanometer has not been constructed to measure the comparatively small currents used on the human body.

THE APPLICATION OF ELECTRICITY TO LIVING TISSUES.

Electricity can be applied in a variety of ways to the human body, and different

results are obtained according to the plan adopted. There is the static machine, the galvanic or voltaic battery, and the dynamo, to give either a continuous or an alternating current, and the induction coil giving an interrupted current. Each of these can be varied through wide limits. The strength of the current can be increased or decreased, the alternations can be varied from 1 per second to 10,000 per second, and the interruptions of the inducted current from 1 to 5,000, or more, per second.

For the various purposes required the electrodes used in the application may be either large or small, near to each other or far apart. They may be needles to pierce the skin, or pads made to lie over the skin in close contact with it. The results obtained will be very various, and according to the method adopted. A dose of electricity depends upon the size of the electrodes and their distance apart, as well as the strength of the current. The amount passing through one square inch of the tissues with an electrode have a surface of 20 square inches, with a current strength

of 100 milliamperes, is five milliamperes for each square inch. If we now use an electrode of two square inches and the same strength of current, we shall be passing 50 milliamperes through each square inch of the tissues nearest to the electrode. The distance between the electrodes also bears upon this point. The wider apart the electrodes are the greater the diffusion of the current. However close the electrodes may be to each other there is always some diffusion of the current, although a large portion of it will take the nearest route from one pole to the other. In order, therefore, to arrive at an estimate of the density of the current passing through the tissues lying between the two poles, we must know the strength of the current, the size of the electrodes, and their distance apart. Even then we must consider a further point, which is of the utmost importance, and that is, the relative conductivity of the various tissues of the body. For instance, fat offers an enormous resistance, while muscles and nerves are comparatively very good conductors. Ac-

According to Hermann these again offer a much greater resistance to currents passed transversely than when passed longitudinally. Bone is a bad conductor, and offers a much higher resistance than muscle or nerve.

The worst conductor of all, except fat, is the skin. The resistance of this again varies in different parts of the body, in individuals, and also at different times in the same individual. When moist with perspiration it conducts best.

The relative conductivity of morbid tissues must also be considered. When two electrodes are placed over the liver—one in front and the other behind—in order to pass a current through it, it does not follow that the attempt will succeed; for if this organ has a higher resistance than the surrounding tissues, the current will go round instead of through it. The same argument applies to tumours. Fibrous tissue, especially when dry and condensed, offers a much higher resistance than muscle and healthy connective tissues. A sarcoma conducts better than a

scirrhus. The latter presents different resistances in its different parts. The outer zone of growing cells conducts best, while the older portion where the fibrous stroma is condensed and hard offers a very high resistance. In one of my early cases there was no recurrence round the tumour, but sprouting took place from the centre, because the current had not penetrated that portion.

THE ACTION OF ELECTRICITY ON ALBUMINOID TISSUES.

This will be found to vary according to the mode of application. We can stimulate nutrition with a mild constant current, increase muscular power by the daily application of a weak Faradic current, disintegrate the complex molecule of albumin by a voltaic current, cauterise the tissues by heat or chemical action, and, if required, rupture the cell walls by a discharge at high pressure.

When a constant voltaic current is passed through the tissues, a regular series of changes occurs. It has long been known

that salts in solution could be decomposed. Let the poles from a battery be passed into a solution of iodide of potassium. The iodine is forcibly separated from the potash, and accumulates round the positive pole while the potash collects round the negative. This is the simplest form of electrolysis. It will be observed that the liberated elements, iodine and potash, only make their appearance in the close neighbourhood of the two poles, that is, at the points where the current enters and leaves the fluid; in between there is nothing to be seen. The atoms thus severed from one another, and carried invisibly by the current to the electrodes, are called ions. Those that go to the positive pole are Anions, while the negative are called Kathions. The amount of an ion liberated at an electrode is proportional to the strength of the current. For instance, two ampères will liberate double as much as one ampère. The question naturally arises—Do the liberated elements come from the molecules only in contact with the electrodes, or from the whole of the area traversed by the

current? Supposing the former takes place, it stands to reason that in order to cause decomposition in new growths, it would be necessary to bring the electrode in direct contact with every part of it, whereas, if the decomposition takes place throughout the tissue traversed by the current, this would not be necessary.

The body may be said, from an electrical point of view, to be approximately one large cell with an infinite number of partitions formed by the numberless cell walls and layers of connective tissue and fascia. There will, then, be only two points at which the products of electrolysis will appear, viz., at the two electrodes. In order to ascertain whether these products come from the whole of the tissues through which the current passes, or only from those in close contact with the electrodes, I devised the following experiments :—

Three glasses are connected by pieces of thick cord, which is a non-conductor, saturated in the same solution as contained in the glasses. The centre is filled with a solution

of iodide of potash, and the two outer with a solution of chloride of sodium, each solution having a sp. gr. of 1080. Into each glass a pinch of starch powder is placed. The two electrodes are then introduced one into each of the outer glasses. These three glasses represent one cell in three divisions, and the elements liberated by the current appear only at two points where the electrodes enter the solutions. The apparatus is thus analogous to the human body in that it forms one electrical cell with divisions. If the molecules throughout the path of the current are decomposed, then each glass will lose an equal amount of the salts in solution. After passing a powerful current, and decomposing the whole of the chloride of sodium in the two outer glasses, it was found that the iodide of potash solution in the centre glass was untouched. There was not the least alteration in it, although the transport of elements which takes place during electrolysis must have caused the atoms of chlorine and soda to traverse the fluid contained in it. A second experiment with the same apparatus

was then tried, with all three glasses filled with a standard solution of the iodide of potash. A current was then passed until the whole of the iodide in the two end glasses was decomposed. At the positive end was an orange solution of iodine and water, while the other end glass with the negative pole contained nothing but potash and water. I quite expected to find some alteration in the centre glass, but was disappointed. The solution remained unaltered. A similar experiment was then tried with water in the two outer glasses and iodide of potash in the centre. Again the water in the two end glasses was decomposed, while the solution in the centre or interpolar glass remained unaltered. It is most important in carrying out this experiment to connect the glasses by a non-conductor which will absorb some of the fluid, because if the glasses are connected by wires the apparatus is converted into three cells, instead of forming one with divisions, and the centre glass no longer represents the interpolar region. A further experiment was then carried out as follows:

—A current of one milliampère was passed for ten seconds through the web of a frog's foot, and the operation was watched through the microscope with a one-inch objective. The changes occurring at each pole could be examined, and of these I shall speak again, but there was no change to be seen in the space between the poles; the circulation went on as before.

It would appear, then, from these experiments, that the constant current only decomposes the molecules in close proximity to the electrodes, and that it is impossible to bring this action into play over a large area, except by frequently changing the position of the electrodes.

There is another change which takes place in the neighbourhood of the electrodes from the presence of free acids at the positive and free alkalis at the negative poles, the result of the decomposition of molecules. A secondary caustic action is thus brought about which is very destructive to living tissues. The acids appear to destroy more than the alkalis. When the progress is

watched on the frog's foot, the area of coagulation at the positive pole is five times as large as that at the negative. Although at the negative pole numerous bubbles of hydrogen gas could be seen, they did not appear to interfere with the living tissues in contact with them.

The amount of destruction that can be achieved by the molecular decomposition and secondary caustic action, which are both going on simultaneously while the current passes, is limited. For instance, with one needle and a current of 200 milliamperes, the area of destruction is about one square inch. Polarisation occurs, and an opposing electromotive force is set up, and in the course of a few minutes the current falls to zero. I have found that it varies according to the tissues acted upon. If a powerful current is used for a few seconds, and the effect is compared with a weak current spread over a longer time so as to be equal in amount, the destruction appears to me to be greater with the powerful for a short time than with a weak current for a longer time, although the

amount of electrolysis is the same. Possibly the powerful current, apart from electrolysis, injures living albumin in some way, which the weak current is unable to do.

Although the greater part of the energy of the constant current is expended in electrolysis, a certain amount is developed into heat. With only two small platinum needles this soon becomes apparent when the current exceeds 250 millampères. Although we can go up to 300 or 400 millampères without producing actual redness of the platinum points, sufficient heat is developed when the current strength exceeds 250 millampères to be destructive to living tissues in contact with the needles. When the current is alternated and only allowed to pass for a second at a time with a pause of some seconds between each alternation, the temperature of the platinum points is only slightly raised.

There is another and a very important action which goes on during the passage of a current through the body, called the transport of elements. I have already pointed

out that when iodide of potassium in solution is split up into its constituent elements, these are separated from one another, the iodine appearing at the positive pole, while the potash appears at the negative. At whatever point the decomposition takes place, it is evident that one or both elements must cross the intervening space to reach the two poles. It is curious that they cannot be detected during their transit from one pole to the other. It is supposed that the molecules lying in the path of the current exchange atoms with those in the neighbourhood of the poles. Although the molecules in the space between the poles do not disappear or diminish in quantity, there is very little doubt but that some of their atoms have been replaced by others during the passage of a current. There is every reason to believe that under given circumstances they can be forced to exchange the atoms of one element for those of another. Grotthuss' hypothesis seems to explain the facts. He believed that the molecules of the liquid arrange themselves in innumerable chains,

in which every molecule has its constituent atoms pointing in a certain direction, the atom of electro-positive substance being attracted towards the kathode, and the fellow atom of electro-negative substance being attracted towards the anode. An interchange of partners then goes on between the separate atoms all along the line.

I have some reason to think from the following experiment that it is the positive pole alone which splits up the molecules in electrolysis. If two glasses are connected together by a woollen cord saturated with water, and one contains some iodide of potash and the other plain water, it will be found that when the positive pole is placed in the water, and the negative in the iodide solution, this solution is not decomposed. But if the poles are changed it is found that the positive pole can split up the iodide and force the potash across the cord into the glass with water that contains the negative pole.

We are not yet in a position to say what are the products of the electrolysis of albuminoid tissues beyond stating that soda,

potash and hydrogen can be verified at the negative pole, while oxygen and chlorine sulphur are found at the positive.

I have already described the caustic action produced by these bodies in the neighbourhood of the electrodes, and the destruction of tissue which is perfectly evident to the operator. In addition to this it is necessary to consider what effect, if any, is caused by the transport of elements through the tissues in the interpolar region. The experiments already described show that they are not disintegrated by the current, but at the same time there can be little doubt but that they are forced to exchange atoms. Observations on fibromyomata of the uterus treated by a constant current show that their nutrition is interfered with, and that they become smaller and in some cases disappear entirely.

With malignant disease we have to deal with albuminoid tissues of much higher vitality and greater resisting power than are found in fibromyomata. When a constant current is applied, the same destruction takes place round the electrodes, but in the inter-

polar region, the nutrition of the cells appears to be unaffected by the transport of elements. It soon becomes evident, then, that a constant current is of no value for malignant disease unless we are dealing with small growths that can be entirely destroyed by the caustic action of the poles. This led me to discard the constant current, and to consider whether electricity might not be applied by a more efficacious method. It occurred to me that the sudden discharges of a powerful current, especially if alternated, would produce a more destructive action between the poles, and thus lead to an atrophy of the cells throughout the path it traversed. That this does take place, but in an unequal manner, there is no doubt whatever. For the successful application of this method the relative conductivity of the tumour to the surrounding tissues and of its own component parts and several other factors must be understood. Considerable clinical experience is also essential in order to form a correct opinion of the extent and ramifications of the malignant growth. It is, however, much easier to treat a case of rodent

cancer on the surface of the body, where the extent of the disease can be seen and the amount of destruction by the electrical current watched, than a case of tumour covered by the tissues and excluded from view.

TREATMENT.

Whatever method of treatment be adopted the object aimed at is the complete destruction of the disease, with as little harm to the healthy tissues as possible, so as to avoid disfigurement of the face. There are three agents which can be employed for this purpose : electricity, caustics, and the knife.

ADVANTAGES OF ELECTRICITY.

Electricity used in the mode about to be described has these advantages :—(1) It causes no pain ; in fact, for several days after the application, sensation in the ulcer is abolished. (2) When it is applied there is no loss of blood beyond a possible drop or two. This absence of hæmorrhage is a great

benefit in more than one way. It enables the operator to see exactly what he is about, and to destroy no more tissue than is absolutely necessary, while it saves the patient from the debility which follows a large loss of blood. (3) By the electrical method the amount of destruction can be regulated with the greatest nicety. The strength of the current can be increased or reduced within the widest limits. (4) The resulting cicatrix is smaller and there is less deformity than when other means are employed.

With regard to excision by the knife. No doubt complete healing can be achieved, and if all the disease has been thoroughly removed, the result is satisfactory. But however brilliant the operator may be, the profuse hæmorrhage which occurs, renders his task exceedingly difficult. Not only is it unnecessary to cut wide of the disease in many cases, but it is most important on account of the subsequent disfigurement of the face to avoid removing more than is absolutely necessary. How can this be done when the face is flooded with blood?

I know of one instance where the operator was obliged to desist while chloroform was substituted for ether on account of the profuse hæmorrhage. I operated upon the same case at a later date by electricity when the ulcer was much larger, and there was no hæmorrhage whatever, beyond one or two drops where a needle was inserted. Directly the current is turned on a hæmostatic action is produced, and hæmorrhage is prevented.

The great disadvantage of using caustics, such as the chloride of zinc, nitric acid, and others, is that they cause so much pain. Even the advocates for the use of caustics admit that they are only suitable for small ulcers not larger than half-a-crown. As to dilute caustics and their frequent application, it may be said at once that they are useless. Unless the disease can be entirely destroyed, so as to produce healing, it is best left alone. The chloride of zinc paste appears to be the most useful. It must be left in contact with the growth for some hours in order to penetrate to the necessary

depth. The amount of caustic to apply in order to produce a satisfactory result is very difficult to gauge.

The actual cautery, whether Paquelin's or the galvano, is thoroughly efficient. Here again it is extremely difficult for the operator, when using a red-hot platinum point or wire, to regulate the amount of destruction with any nicety. In two of my cases the disease extended up to the inner canthus of the eye and just touched the conjunctiva. Under these circumstances great care is necessary. With electrolysis, the amount of destruction can be regulated with the greatest ease, by diminishing or increasing the number of cells in circuit.

OPERATION.

When possible I prefer nitrous oxide, followed by ether, to any other anæsthetic, but chloroform answers very well. For old people over 65, the A.C.E. mixture seems to be the best. The ether inhaler very often gets in the way, when the disease is on the face. I never feel anxious about

chloroform so long as the administrator gives plenty of it until the patient is under, and then as little as possible to keep her under. The operating table must be placed in a good light, the batteries parallel to the table, and on the opposite side to the operator. They should be freshly charged and tested before the anæsthetic is given, and so arranged that the rails on which the sledge glides are continuous. Any strength from two cells to eighty can be used as required, without loss of time in passing from one battery to the other. The galvanometer is placed on a small pedestal table standing between the batteries and the operating table, in such a position that the operator can see the strength of the current registered without having to turn his head. The two wires from the battery are laid across the patient ready for connection as soon as the needles are in position. Two assistants are required, one to work the batteries and the other to assist the operator. The nine needles used are from two to four inches long, composed of steel with platinum

ends. The steel portion is insulated, and attached to about eighteen inches of covered wire. When they are in position, the wires leading from them are connected to those from the battery. The circuit is then complete.

When the patient is fully under, the assistant at the battery is directed to use twenty cells, and then to turn the current on for one or more seconds as required. Meanwhile the other assistant holds the needles in position, while the operator keeps his finger on the pulse, notices the strength of the current shown by the galvanometer, and observes the effect produced on the growth. After one or more seconds the current is turned off. If the breathing and the pulse are unaffected the circuit is made again, but in a reverse direction by means of the commutator on the battery.

The number of cells in circuit is now increased, until the galvanometer shows a current of 300 to 400 milliamperes, provided the pulse and respiration remain unaffected. The assistant continues to alter-

nate the current and increase or diminish its strength according to the wishes of the operator. The position of the needles must be changed when sufficient destruction has taken place. A fresh portion is then treated until the whole of the growth is destroyed. Full advantage is taken of the caustic action at the poles. Between the needles there is also some destruction of the tissues lying in the direct path of the current between the poles. This is not so apparent at the time of operation as the polar action ; it is better observed forty hours later. Although most of the current passes by the shortest route from one needle to the other, some of it is diffused and goes through the healthy tissues lying outside the growth. In this region it is much weaker, and appears to have a stimulating effect on the healthy tissues.

DURATION OF OPERATION.

This will depend upon the extent of the growth. A small ulcer would not take more than ten minutes or a quarter of an hour.

When very extensive, it is better to make more than one application rather than keep the patient over an hour under an anæsthetic. There is a great difference in the capacity of individuals for chloroform and ether. In some instances the anæsthetic has no effect upon them at all, while in others it upsets the nervous system for a day or two and causes great nausea.

RISK OF THE OPERATION.

I have never lost a case of rodent cancer by operation, so that I consider the risk to be almost *nil*. Case No. I. was over 70 years old, and Case No. II. was 85. At first I refused to operate on the latter on account of the great age. However, the operation passed off quite safely. Up to the present I have not noticed any alteration of the pulse when operating on the face. Considerable twitching of the muscles takes place. There appears to be only one part of the body unable to stand a slowly alternated current of 300 to 400 milliampères, and that is the area

over the base of the heart and parts of the neck. In some parts I have used as much as 1,000 milliamperes, but then the electrodes have never been more than four inches apart. On the face there is very little risk of the current passing into the brain, because both electrodes lie to one side of it, and the resistance of the bone through which the current would first have to pass before it could touch the brain is much greater than that of the soft tissues lying between the needles.

AFTER TREATMENT.

The chief indication is to have the ulcer well syringed with an antiseptic solution. For this purpose I prefer boric acid, on account of its non-irritating properties. For the first forty-eight hours the wound should be covered with a piece of lint kept moist with spirit lotion. It prevents some of the swelling, and is cool and soothing to the patient.

There is no depression following the application of electricity, and as soon as the patient

has recovered from the anæsthetic she feels herself again. Nor is there any pain as a rule, in fact, sensation is almost abolished for several days. As a rule, patients can get up the day after the operation. When the wound begins to granulate, the usual sensation of a healing ulcer is experienced. The part destroyed separates in the form of *débris* from the seventh to the tenth day. Boric acid ointment answers as well as anything for a dressing. In some instances skin grafting materially hastens the healing, but in my experience it does not prevent the subsequent contraction produced by the cicatricial tissue. In most instances this contraction is of great advantage, because it draws the loose skin of the face over the surface of the granulations to the extent of nearly an inch in some cases and reduces the size of the cicatrix. When the disease occurs on the lips, a plastic operation may be necessary to preserve the symmetry of the face, because the contraction draws together not only the skin, but also the underlying soft tissues of the lip, which are not attached to any solid structure capable of keeping them in place.

NUMBER OF APPLICATIONS.

This will depend upon the extent of the disease and the capacity of the patient for taking an anæsthetic. For an ordinary case one application is enough. Out of the four cases described, three of them were healed by one application, although Case No. III. was very extensive. Case IV., which required three, was an advanced and extremely difficult case, and the patient preferred to have it done in three applications rather than suffer from the discomfort caused by a prolonged administration of the anæsthetic.

PROGNOSIS.

It must be borne in mind that the four cases upon which the prognosis is based were all bad cases, where every other method of treatment had been tried. The results obtained are therefore all the more significant, and a much better prognosis could be given in an early case.

Healing usually takes place in a few weeks. The time required will, of course, depend

upon the size of the ulcer and the patient's constitution. The position of the ulcer is also a factor to be considered. Over cartilage or bone it is much slower than over the soft tissues where contraction can easily take place.

Out of four cases the first case kept well for eighteen months, when a small spot appeared. This healed after a second application, and is now quite well. The second case healed after one application two years ago and there has been no recurrence. The third case healed after one application and kept well almost a year, and then two applications were made. She is now well again. The fourth case healed after three applications, and has kept well up to the present, now eighteen months.

A year's immunity can always be promised, with probability of a longer period, even in bad cases. If any little spots of disease appear, a touch with the needles will soon dissipate them. Recurrence can be avoided for a long time if a free destruction of the disease with a margin of healthy tissue round, so as to ensure entire removal of every

morbid cell, irrespective of the disfigurement that will ensue, be carried out. On the other hand, if we wish to avoid disfigurement, a destruction only of the apparent limits of the disease is better. Then we can wait events, and if any little spots appear in a few months or a year after healing takes place, a second application ought to eradicate it for some time. The latter method is, I think, the better, because it is only in a few spots that the morbid cells extend more than a few lines into the healthy tissues, and we thus avoid any unnecessary destruction.

CASES.

In my description of the following cases I have purposely left out the names of the surgeons who operated on them before they came under my charge. It is only fair to state that these names include some of the leading surgeons of the day, and that in each of these four cases everything had been done that could be done by the highest skill with the knife and caustics before the patients came under my care.

Case No. I.—RODENT CANCER OF THE FACE OF SIXTEEN YEARS' DURATION, HEALED BY ONE APPLICATION OF ELECTRICITY.

G., age 71, sent to me by Dr. William Anderson, of Richmond, Surrey, June, 1891. Sixteen years ago a pimple appeared on the inner side of the nose, which went on to ulceration and used often to bleed. One of the leading surgeons of the day applied caustics to it, but it never healed completely, and in a few months began to increase again. Two years later caustics were again applied, but without success. It was then completely excised by the knife, and healed. The patient remained well after this for over a year. The disease then appeared again and became much worse, and has continued to extend.

The patient is well nourished, and enjoys fairly good general health, but has a somewhat irregular pulse, without any other signs of cardiac disease. Between the side of the nose and right eye is a somewhat deep, excavated ulcer. It extends from the middle of



DIAGRAM I.

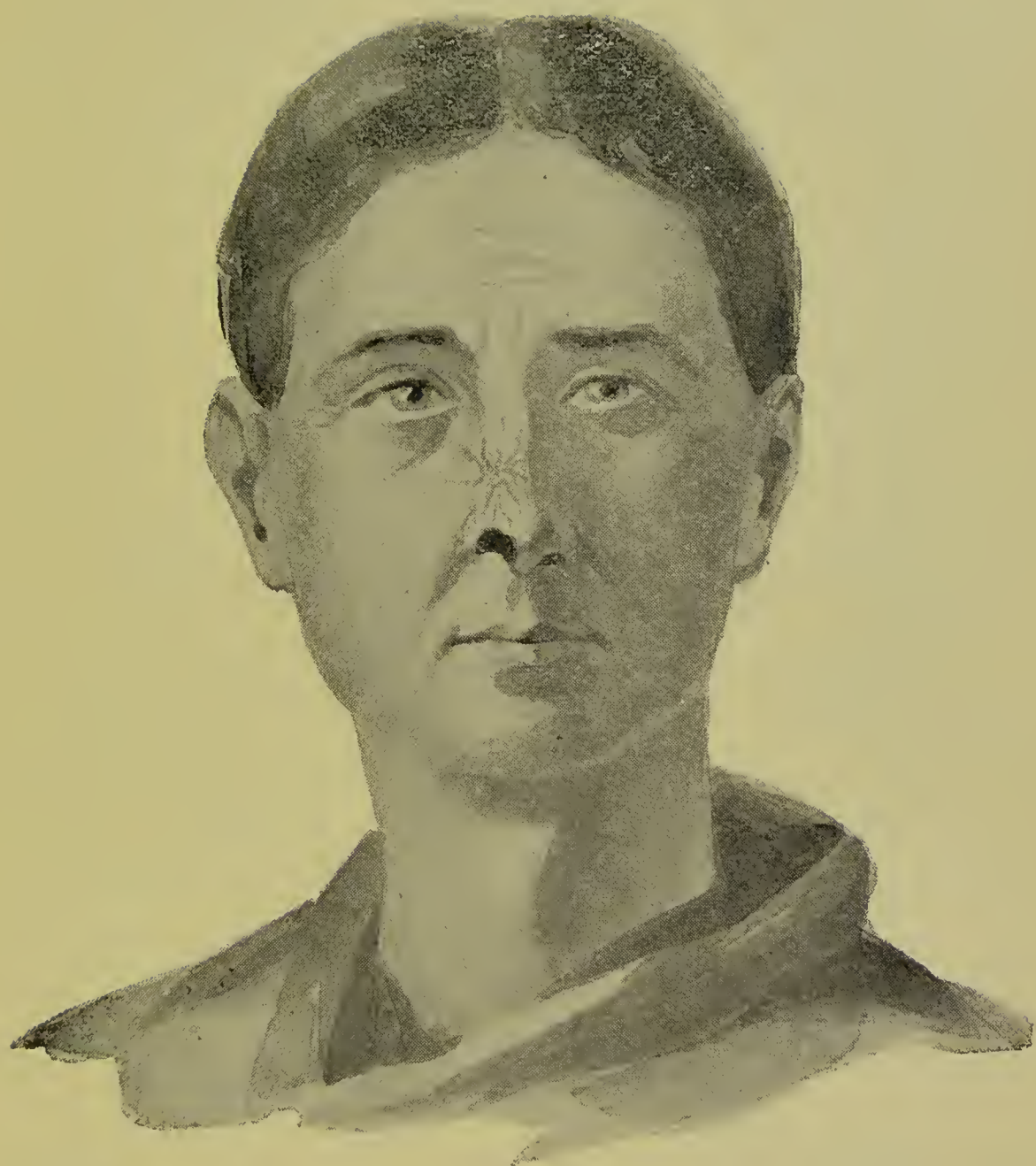


DIAGRAM II

the side of the nose to the inner canthus, reaching close up to the mucous membrane of the eye, but not involving it. The base of the ulcer extends down to the periosteum, and has burrowed into the hollow between the nasal bone and the eye. The edges of the ulcer are irregular, dentated, and raised in places. The base is of a dull, red colour, smooth, glazed, and devoid of granulations. The patient was very anxious that the eye should be preserved, and the disease destroyed without injury to it.

On July 25th, 1891, I operated with the assistance of Dr. Anderson and Dr. Gardiner. The A.C.E. mixture was given, and the pulse rather improved. Two Stohrer hospital batteries of 40 cells were used joined together in series. The needles were inserted, and the current gradually raised to 400 milli-ampères and alternated. The whole of the growth was gone over and destroyed in the course of an hour. Great care was necessary in doing the portion close to the eye. This was successfully accomplished without any injury to the conjunctiva. There was no

alteration in the pulse or the breathing during the operation. No loss of blood occurred, and the following day the patient was able to get up. The temperature remained normal. Very little swelling occurred. After a few days some discharge took place from the ulcer, and at the end of ten days most of the sloughs had separated. In a fortnight the wound was covered with granulations and began to heal. In six weeks it was completely healed. The resulting cicatrix was very much smaller than the original ulcer, and the symmetry of the eye was not interfered with. The eyesight was as good as ever.

I saw this patient from time to time, and the cicatrix remained perfectly healthy for one year and six months. A little spot of disease then made its appearance. Three months later, in April, 1893, I thought it advisable to make a second application of electricity, just one year and nine months after the first operation. The ulcer had the usual characteristic appearance, but was very much smaller than the original, and did not

extend to the eye as before. On April 7th, with the assistance of Dr. Gardiner and Dr. Harper, I thoroughly destroyed the ulcer. A.C.E. was used as before. The operation only took twenty minutes. At the end of May, 1893, I heard from Dr. Gardiner that the ulcer had healed perfectly and the patient gone into the country.

I saw this patient at the end of August, 1893. The cicatrix was beautifully firm and healthy, and the general health excellent.

Case No. II.—RODENT CANCER OF THE FACE OF NINE YEARS' STANDING, AND INVOLVING THE LEFT EYE, IN A PATIENT OVER 85 YEARS OF AGE, HEALED BY ONE APPLICATION OF ELECTRICITY.

N., age 85, sent to me June 16th, 1891, by Dr. William Anderson, of Richmond, Surrey. The disease commenced nine years ago. Caustics were applied in January, 1884, and in June, 1885, but without much benefit. In 1885 it was completely excised by a Metropolitan surgeon. The wound healed and remained well until 1888. The disease then

recurred, and has continued to advance up to the present time.

There is now an evident rodent ulcer, with the usual dentated appearance, but without any raised edge. The base is of a dull red colour and devoid of granulations. It extends from the side of the nose to the left eye, and involves both eyelids and the conjunctiva as far as the cornea. The eyelids cannot be closed, and vision is quite lost through the left eye. The ulcer on the face is excavated and extends down to the periosteum. Vision in the right eye is still good. There is much itching and irritation in the ulcer.

The heart and lungs appear to be quite sound.

After consultation with Dr. Anderson I decided to decline the case.

There was no hope of exterminating the disease without destroying a portion of the left eye. In a patient of this great age it was not improbable that sloughing of the eyeball might follow, with the risk of sympathetic ophthalmia in the right eye and total blind-

ness. Apart from this, any operation which involved the taking of an anæsthetic might easily be followed by a fatal result in a patient of such great age. The patient did not wish anything done which would jeopardise the sight of the right eye.

When this patient heard that the ulcer of Case No. I. had completely healed, I received another visit, and was strongly pressed to undertake the treatment. This I consented to do if the eyeball were excised first. After a consultation with Mr. Makins, this was decided upon, and on September 7th, 1891, A.C.E. was administered, and Mr. Makins removed the left eye. The patient made a quick recovery. On September 25th, 1891, A.C.E. was again administered, and the whole of the disease was destroyed by electricity. The strength of the current did not exceed 300 milliampères. The pulse kept very good, and the operation lasting forty minutes was well borne. An uninterrupted recovery followed, and at the end of a month the wound was completely healed. There was still some itching and irritation in the scar.

This was probably due to the great age of the patient. A year later, in 1892, the scar remained sound. In March, 1893, there was some rawness of the skin, and I rubbed it over with the nitrate of silver stick. When, in June, 1893, I saw Dr. Gardiner, who was attending the case in Dr. Anderson's absence, he informed me that it was quite healed and the patient well.

Case No. III.—RODENT CANCER OF THE FACE OF TEN YEARS' DURATION, INVOLVING THE NOSE AND UPPER LIP AND SOFT TISSUES, HEALED IN ONE APPLICATION.

D., age 48, sent by Dr. Wm. Anderson, Richmond, S.W. Some ten years ago a small pimple appeared at the junction of the right ala of the nose with the upper lip. Ulceration soon followed and the disease extended. Two years later it was scraped, and healed up for a few months. About four years ago it was completely excised, and she remained well for two years. Ulceration again appeared, and the disease has continued to spread up to the present time.

The upper lip on the right side of the face is drawn up about half-an-inch, exposing the teeth and gums, and making a V-shaped notch. Extending in all directions round this is an irregular ulcer. Below it extends on to the margin of the upper lip, outwards on to the cheek for over an inch, upwards along the side of the nose. It involves the right ala, which is partly eaten away, and also the right lateral cartilage, and extends up the right nostril along the mucous membrane of the outer wall for an inch, forming a thick edge. The disease has also extended to the mucous membrane over the septum, where it is ulcerated, and has exposed the cartilage and periosteum.

December 2, 1891.—Chloroform was administered, and with the assistance of Drs. Anderson and Gardiner, I applied electricity to the whole of the growth and ulcer. It was extremely difficult to see the exact limits of the disease in the interior of the right nostril. The introduction of the needles and holding them in position blocked the light. To add to the difficulties, she required a

large quantity of chloroform, and kept coming round from the anæsthetic, and I had many times to desist and wait until she was got under again. The operation took an hour and a-half on account of these delays. The growth, especially in the nose, was more vascular than the others, and showed a greater tendency to bleed when the needles were inserted. As soon as the current was turned on this was at once stopped, and only a few drops of blood were lost. She remained under Dr. Gardiner's charge, and had a good deal of sickness from the chloroform, but no pain whatever in the wound.

December 12, 1891.—The sloughs had all separated and the wound showed healthy granulations. She complained that when it was syringed the lotion—boro-glyceride—caused much smarting, so chloral lotion was substituted. Dr. Gardiner applied several skin drafts, and a month later the ulcer was completely healed, and her general health had very much improved.

July, 1892.—The cicatrix looked healthy. She was in very good spirits and felt very well.

In November, 1892, nearly twelve months after the application, a small spot appeared on the upper lip. She came up to town, and on November 25th I destroyed it. She was under chloroform for about ten minutes, and left town the next day. This little place soon healed, and she remained well until March, 1893, when she complained of irritation in the nostril. On making a careful examination some ulceration could be seen on the septum. On the 20th March, 1893, I operated again under chloroform. The right side of the upper lip was now connected to the left by a narrow band. This was divided, so as to give more space for getting at the disease within the nostril. It was then found that the ulceration was more extensive. There was the same difficulty with the anæsthetic as before, but it was easier to see into the cavity of the nose. The whole of the ulcerated surface was thoroughly destroyed, and also a suspicious papule on the outer surface of the nose. She remained under Dr. Gardiner's care, and the wound healed completely.

Case No. IV.—RODENT CANCER OF THE FACE OF FOURTEEN YEARS' DURATION, INVOLVING THE CARTILAGES OF THE NOSE AND LEFT NASAL BONE AND SOFT TISSUES, HEALED WITH THREE APPLICATIONS.

A., age 53, a patient of Sir Francis Laking. Fourteen years ago a small papule appeared on the right side of the nose, which slowly ulcerated and would not heal with simple treatment. Caustics were then applied, and it healed up for a time, but soon broke down again. Twelve years ago it was excised. The disease recurred, and two years later the same surgeon excised it again. It was twice excised at a later date by another leading surgeon, but after a period of immunity the disease always recurred. The last time it was excised a competent pathologist pronounced it to be a sarcoma, after examination of some sections taken from the part removed.

There is now a large ulcer on the face, extending from the inner canthus of the right eye down to the tip of the nose and covering

both alæ. On the right side it extends on to the cheek, and also covers the whole of the bridge and both sides of the nose. The cartilages and the left nasal bone are involved (*vide* diagram No. I.). When the black scab was removed the ulcer was found to have the usual dull red appearance, without any granulations. At the sides the edge of the ulcer is but slightly raised, but along the upper and lower margins is a thick raised border, soft and semi-translucent. It is nearly half an inch thick, and near the edge is so high that it forms a partial obstruction to vision. At this point the disease just touches the conjunctiva of the right eye. The general appearance is not unlike a true epithelioma. Plate II., showing the structure of the growth and the presence of large bird's-nest cells, demonstrates how much rodent cancer resembles in structure the infective form of true epithelioma, and how slight the border line must be between the two. A pathologist, looking at this section, who did not know the history of the case, and the absence of lymphatic enlargement, would probably say

that it was true epithelioma, but a glance at plate I. shows the diffuse arrangement of small epithelial cells in an almost structureless matrix, which is more characteristic of rodent cancer.

The general health of this patient was to a certain extent impaired by the discharges from the ulcer and the depression of the nervous system incidental to the presence of the disease.

After consultation with Sir Francis Laking, we decided that it would be better to treat the upper half of the ulcer first, so as to stop the encroachment on the eye. The extent of the disease was too great to go over it all in one application without keeping the patient under an anæsthetic for a longer time than the condition of the general health justified.

April 25, 1892, A.C.E. was given, and with the assistance of Sir F. Laking the upper half of the ulcer was destroyed. The strength of the current was 300 to 400 milli-ampères. There was no bleeding. Considerable care was required to destroy the thickened margin near the eye without

damaging the conjunctiva. A small piece was snipped off for examination under the microscope. The operation took three-quarters of an hour.

No sickness or pain followed, and on the third day the patient was able to get up for a few hours. There was a good deal of swelling in the loose connective tissue of the upper and lower eyelids. This went off in the course of a few days. The wound was carefully kept in an aseptic condition with boracic lotion and ointment. In about eight days' time the sloughs had mostly separated, and some healthy granulations began to show. Sensation in the ulcer had by this time fully returned. By May 9th the upper extremity of the ulcer near the eye had healed for nearly half an inch.

On May 11th I made a second application. A.C.E. was again administered, and with the assistance of Sir F. Laking I went over the remainder of the ulcer. A small piece from the lower margin was removed for examination. The left nasal bone was destroyed and superficial sloughs produced on the nasal

cartilages. This required some dexterity of manipulation, so as not to do too much and produce a hole in the nose. At the time it was impossible to know the extent to which the cartilages were diseased, although the mucous membrane inside the nose was intact. Experience of these cases teaches that rodent cancer has more difficulty in penetrating cartilage than any other structure. We therefore assumed in this case that it was probably only superficial, and that at any rate we would give our patient the chance of keeping the shape of the nose, and only destroy the whole thickness of cartilage if we found that a superficial application was not sufficient. The duration of the operation and the strength of the current were the same as before.

No pain or rise of temperature followed, but a little swelling of the face, which soon subsided. A week after the operation the patient went out for a drive. At the end of twelve days all the sloughs had separated except the nasal bone and a superficial layer of cartilage, and these came away three days

later. Meanwhile the first portion treated was healing rapidly. Ten days later several skin grafts were put on so as to hasten the healing over the cartilage. Near the hollow left by the nasal bone there was a small opening into the nose, but as the wound healed it closed up. By the end of June the greater part of the ulcer had healed, but there were two or three spots over the original site of the disease without healthy granulations. A short application was made under A.C.E. as before, and the last remnants were destroyed. After this the progress was uninterrupted, although slow. At the end of a month the ulcer had healed except a little piece over the cartilage. In the course of a few weeks this also had healed completely. The patient's general health showed a marked improvement. It was wonderful how little the shape of the nose was altered (*vide* diagram II.). The loose skin of the face was drawn together, and the actual cicatrix was not more than one quarter the size of the original ulcer. The right nostril is a little drawn up and everted. The absence of the left nasal bone

appears to make no difference to the bridge of the nose.

July, 1893.—The patient has remained well and has been able to go out into society and enjoy life once more.

September, 1893.—There has been no return of the disease so far, and the patient keeps wonderfully well.

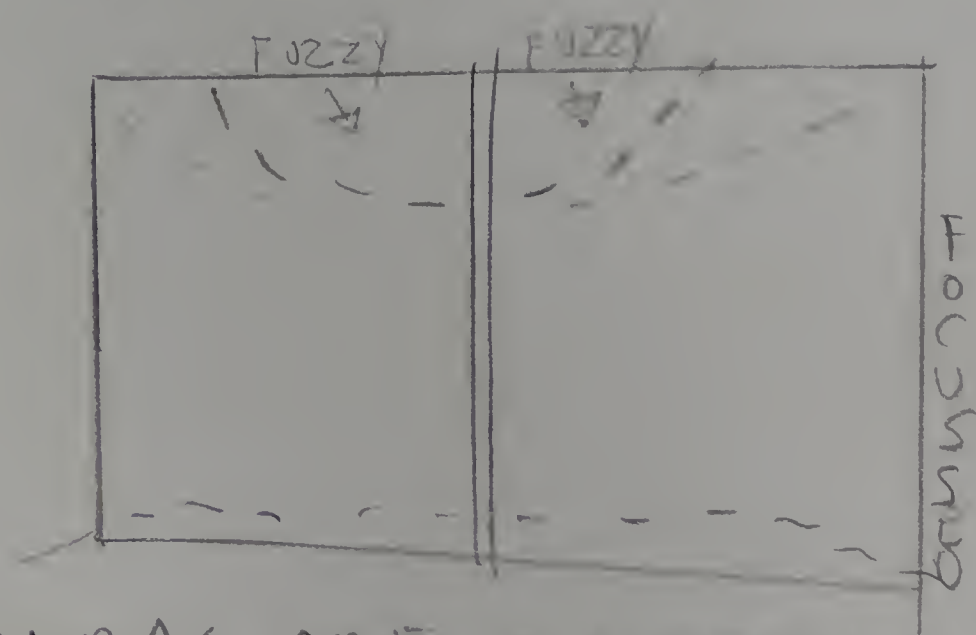




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